

6e. Index of Refraction for Visible Light of Various Solids,  
Gases, and Liquids

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TABLE 6e-1. INDEX OF REFRACTION OF SOME LIQUIDS RELATIVE TO AIR\*

| Substance   | Density | Temp., °C | Indices of refraction          |                                  |                                 |                                 |                                 |
|---|---------|-----------|--------------------------------|----------------------------------|---------------------------------|---------------------------------|---------------------------------|
|   |         |           | 0397 $\mu\text{m}$<br><i>H</i> | 0.434 $\mu\text{m}$<br><i>G'</i> | 0.486 $\mu\text{m}$<br><i>F</i> | 0.589 $\mu\text{m}$<br><i>D</i> | 0.656 $\mu\text{m}$<br><i>C</i> |
| Acetaldehyde, $\text{CH}_3\text{CHO}$ .....                                 | 0.780   | 20        | .....                          | 1.3394                           | 1.3359                          | 1.3316                          | 1.3298                          |
| Acetone, $\text{CH}_3\text{COCH}_3$ .....                                   | 0.791   | 20        | .....                          | 1.3678                           | 1.3639                          | 1.3593                          | 1.3573                          |
| Aniline, $\text{C}_6\text{H}_5\text{NH}_2$ .....                            | 1.022   | 20        | .....                          | 1.6204                           | 1.6041                          | 1.5863                          | 1.5793                          |
| Alcohol, methyl, $\text{CH}_3\text{OH}$ .....                               | 0.794   | 20        | 1.3399                         | 1.3362                           | 1.3331                          | 1.3290                          | 1.3277                          |
| Alcohol, ethyl, $\text{C}_2\text{H}_5\text{OH}$ .....                       | 0.808   | 0         | .....                          | 1.3773                           | 1.3739                          | 1.3695                          | 1.3677                          |
| Alcohol, ethyl.....   | 0.800   | 20        | .....                          | 1.3700                           | 1.3666                          | 1.3618                          | 1.3605                          |
| Alcohol, ethyl, $dn/dt$ .....   | .....   | 20        | .....                          | -0.0004                          | -0.0004                         | -0.0004                         | -0.0004                         |
| Alcohol, n-propyl, $\text{C}_3\text{H}_7\text{OH}$ .....                    | 0.804   | 20        | .....                          | 1.3938                           | 1.3901                          | 1.3854                          | 1.3834                          |
| Benzene, $\text{C}_6\text{H}_6$ .....                                       | 0.880   | 20        | .....                          | 1.5236                           | 1.5132                          | 1.5012                          | 1.4965                          |
| Benzene, $\text{C}_6\text{H}_6$ $dn/dt$ .....                               | .....   | 20        | .....                          | -0.0007                          | -0.0006                         | -0.0006                         | 0.0006                          |
| Bromnaphthalene, $\text{C}_{10}\text{H}_7\text{Br}$ .....                   | 1.487   | 20        | 1.7289                         | 1.7041                           | 1.6819                          | 1.6582                          | 1.6495                          |
| Carbon disulfide, $\text{CS}_2$ .....                                       | 1.293   | 0         | 1.7175                         | 1.6920                           | 1.6688                          | 1.6433                          | 1.6336                          |
| Carbon disulfide.....   | 1.263   | 20        | 1.6994                         | 1.6748                           | 1.6523                          | 1.6276                          | 1.6182                          |
| Carbon tetrachloride, $\text{CCl}_4$ .....                                  | 1.591   | 20        | .....                          | 1.4720                           | 1.4676                          | 1.4607                          | 1.4579                          |
| Chinolin, $\text{C}_9\text{H}_7\text{N}$ .....                              | 1.090   | 20        | .....                          | 1.6679                           | 1.6470                          | 1.6245                          | 1.6161                          |
| Chloral, $\text{CCl}_3\text{CHO}$ .....                                     | 1.512   | 20        | .....                          | 1.4679                           | 1.4624                          | 1.4557                          | 1.4530                          |
| Chloroform, $\text{CHCl}_3$ .....   | 1.489   | 20        | 1.463                          | 1.458                            | 1.4530                          | 1.4467                          | 1.4443                          |
| Decane, $\text{C}_{10}\text{H}_{22}$ .....                                  | 0.728   | 14.0      | .....                          | 1.4200                           | 1.4100                          | 1.4108                          | 1.4088                          |
| Ether, ethyl, $\text{C}_2\text{H}_5\text{O}\cdot\text{C}_2\text{H}_5$ ..... | 0.715   | 20        | .....                          | 1.3607                           | 1.3576                          | 1.3538                          | 1.3515                          |
| Ether, ethyl, $dn/dt$ .....   | .....   | 20        | .....                          | -0.0006                          | -0.0006                         | -0.0006                         | -0.0006                         |
| Ethyl nitrate, $\text{C}_2\text{H}_5\text{O}\cdot\text{NO}_2$ .....         | 1.109   | 20        | .....                          | 1.395                            | 1.392                           | 1.3853                          | 1.3830                          |
| Formic acid, $\text{H}\cdot\text{CO}_2\text{H}$ .....                       | 1.219   | 20        | .....                          | 1.3804                           | 1.3764                          | 1.3714                          | 1.3693                          |
| Glycerine, $\text{C}_3\text{H}_8\text{O}_3$ .....                           | 1.260   | 20        | .....                          | 1.4828                           | 1.4784                          | 1.4730                          | 1.4706                          |
| Hexane, $\text{CH}_3(\text{CH}_2)_4\text{CH}_3$ .....                       | 0.660   | 20        | .....                          | 1.3836                           | 1.3799                          | 1.3754                          | 1.3734                          |
| Hexylene, $\text{CH}_2(\text{CH}_2)_4\text{CH}_2$ .....                     | 0.679   | 23.3      | .....                          | 1.4059                           | 1.4007                          | 1.3945                          | 1.3920                          |
| Methylene iodide, $\text{CH}_2\text{I}_2$ .....                             | 3.318   | 20        | 1.9027                         | .....                            | 1.7092                          | 1.7417                          | 1.7320                          |
| Methylene iodide $dn/dt$ .....  | .....   | 20        | .....                          | .....                            | -0.0007                         | -0.0007                         | -0.0006                         |
| Naphthalene, $\text{C}_{10}\text{H}_8$ .....                                | 0.962   | 98.4      | .....                          | .....                            | 1.6031                          | 1.5823                          | 1.5746                          |
| Nicotine, $\text{C}_{10}\text{H}_{14}\text{N}_2$ .....                      | 1.012   | 22.4      | .....                          | 1.5439                           | .....                           | 1.5239                          | 1.5198                          |
| Octane, $\text{CH}_3(\text{CH}_2)_6\text{CH}_3$ .....                       | 0.707   | 15.1      | .....                          | 1.4097                           | 1.4046                          | 1.4007                          | 1.3987                          |
| Oil:  |         |           |                                |                                  |                                 |                                 |                                 |
| Almond.....   | 0.92    | 0         | .....                          | .....                            | 1.4847                          | 1.4782                          | 1.4755                          |
| Anise seed.....   | 0.99    | 15.1      | 1.6084                         | .....                            | 1.5743                          | 1.5572                          | 1.5508                          |
| Anise.....  | 0.99    | 21.4      | .....                          | .....                            | 1.5647                          | 1.5475                          | 1.5410                          |
| Bitter almond.....  | 1.06    | 20        | .....                          | 1.5775                           | 1.5623                          | .....                           | 1.5391                          |
| Cassia.....   | .....   | 10        | 1.7039                         | .....                            | 1.6389                          | 1.6104                          | 1.6007                          |
| Cassia.....   | .....   | 22.5      | 1.6985                         | .....                            | 1.6314                          | 1.6026                          | 1.5930                          |
| Cinnamon.....   | 1.05    | 23.3      | .....                          | .....                            | 1.6508                          | 1.6188                          | 1.6077                          |
| Olive.....  | 0.92    | 0         | .....                          | .....                            | 1.4825                          | 1.4763                          | 1.4738                          |
| Rock.....   | .....   | 0         | .....                          | .....                            | 1.4644                          | 1.4573                          | 1.4545                          |
| Turpentine.....   | 0.87    | 10.6      | 1.4939                         | .....                            | 1.4817                          | 1.4744                          | 1.4715                          |
| Turpentine.....   | 0.87    | 20.7      | 1.4913                         | .....                            | 1.4793                          | 1.4721                          | 1.4692                          |
| Pentane, $\text{CH}_3(\text{CH}_2)_3\text{CH}_3$ .....                      | 0.625   | 15.7      | .....                          | 1.3645                           | 1.3610                          | 1.3581                          | 1.3570                          |
| Phenol, $\text{C}_6\text{H}_5\text{OH}$ .....                               | 1.060   | 40.6      | .....                          | 1.5684                           | 1.5558                          | 1.5425                          | 1.5369                          |
| Phenol.....   | 1.021   | 82.7      | .....                          | .....                            | 1.5356                          | .....                           | 1.5174                          |
| Styrene, $\text{C}_6\text{H}_5\text{CH}=\text{CH}_2$ .....                  | 0.910   | 16.6      | .....                          | 1.5816                           | 1.5659                          | 1.5485                          | 1.5419                          |
| Thymol, $\text{C}_{10}\text{H}_{14}\text{O}$ .....                          | 0.982   | .....     | .....                          | .....                            | 1.5386                          | .....                           | 1.5228                          |
| Toluene, $\text{CH}_3\cdot\text{C}_6\text{H}_5$ .....                       | 0.86    | 20        | .....                          | 1.5170                           | 1.5070                          | 1.4955                          | 1.4911                          |
| Water, $\text{H}_2\text{O}$ .....   | .....   | 20        | 1.3435                         | 1.3404                           | 1.3372                          | 1.3330                          | 1.3312                          |
| Water.....  | .....   | 0         | 1.3444                         | 1.3413                           | 1.3380                          | 1.3338                          | 1.3319                          |
| Water.....  | .....   | 40        | 1.3411                         | 1.3380                           | 1.3349                          | 1.3307                          | 1.3290                          |
| Water.....  | .....   | 80        | 1.3332                         | 1.3302                           | 1.3270                          | 1.3230                          | 1.3213                          |

\* "Smithsonian Physical Tables," 1954, Table 551.

TABLE 6e-2. INDEX OF REFRACTION FOR SOLUTIONS OF SALTS AND ACIDS RELATIVE TO AIR\*

| Substance   | Density         | Temp., °C        | Indices of refraction for spectrum lines |                  |                  |                            |               |                  |                  |                  |                  |
|---|-----------------|------------------|--|------------------|------------------|----------------------------|---------------|------------------|------------------|------------------|------------------|
|   |                 |                  | C  | D                | F                | H <sub>γ</sub>             | H             |                  |                  |                  |                  |
| Solutions in Water  |                 |                  |  |                  |                  |                            |               |                  |                  |                  |                  |
| Ammonium chloride.....  | 1.067           | 27.05            | 1.37703                                  | 1.37936          | 1.38473          | .....                      | 1.39336       |                  |                  |                  |                  |
| Ammonium chloride.....  | 1.025           | 29.75            | 1.34850                                  | 1.35050          | 1.35515          | .....                      | 1.36243       |                  |                  |                  |                  |
| Calcium chloride.....   | 1.398           | 25.65            | 1.44000                                  | 1.44279          | 1.44938          | .....                      | 1.46001       |                  |                  |                  |                  |
| Calcium chloride.....   | 1.215           | 22.9             | 1.39411                                  | 1.39652          | 1.40206          | .....                      | 1.41078       |                  |                  |                  |                  |
| Calcium chloride.....   | 1.143           | 25.8             | 1.37152                                  | 1.37369          | 1.37876          | .....                      | 1.38666       |                  |                  |                  |                  |
| Hydrochloric acid.....  | 1.166           | 20.75            | 1.40817                                  | 1.41109          | 1.41774          | .....                      | 1.42816       |                  |                  |                  |                  |
| Nitric acid.....  | 1.359           | 18.75            | 1.39893                                  | 1.40181          | 1.40857          | .....                      | 1.41961       |                  |                  |                  |                  |
| Potash (caustic).....   | 1.416           | 11.0             | 1.40052                                  | 1.40281          | 1.40808          | .....                      | 1.41637       |                  |                  |                  |                  |
| Potassium chloride.....   | Normal solution |                  | 1.34087                                  | 1.34278          | 1.34719          | 1.35049                    | .....         |                  |                  |                  |                  |
| Potassium chloride.....   | Double normal   |                  | 1.34982                                  | 1.35179          | 1.35645          | 1.35994                    | .....         |                  |                  |                  |                  |
| Potassium chloride.....   | Triple normal   |                  | 1.35831                                  | 1.36029          | 1.36512          | 1.36890                    | .....         |                  |                  |                  |                  |
| Soda (caustic).....   | 1.376           | 21.6             | 1.41071                                  | 1.41334          | 1.41936          | .....                      | 1.42872       |                  |                  |                  |                  |
| Sodium chloride.....  | 1.189           | 18.07            | 1.37562                                  | 1.37789          | 1.38322          | 1.38746                    | .....         |                  |                  |                  |                  |
| Sodium chloride.....  | 1.109           | 18.07            | 1.35751                                  | 1.35959          | 1.36442          | 1.36823                    | .....         |                  |                  |                  |                  |
| Sodium chloride.....  | 1.035           | 18.07            | 1.34000                                  | 1.34191          | 1.34628          | 1.34969                    | .....         |                  |                  |                  |                  |
| Sodium nitrate.....   | 1.358           | 22.8             | 1.38283                                  | 1.38535          | 1.39134          | .....                      | 1.40121       |                  |                  |                  |                  |
| Sulfuric acid.....  | 1.811           | 18.3             | 1.43444                                  | 1.43669          | 1.44168          | .....                      | 1.44883       |                  |                  |                  |                  |
| Sulfuric acid.....  | 1.632           | 18.3             | 1.42227                                  | 1.42466          | 1.42967          | .....                      | 1.43694       |                  |                  |                  |                  |
| Sulfuric acid.....  | 1.221           | 18.3             | 1.36793                                  | 1.37009          | 1.37468          | .....                      | 1.38158       |                  |                  |                  |                  |
| Sulfuric acid.....  | 1.028           | 18.3             | 1.33663                                  | 1.33862          | 1.34285          | .....                      | 1.34938       |                  |                  |                  |                  |
| Zinc chloride.....  | 1.359           | 26.6             | 1.39977                                  | 1.40222          | 1.40797          | .....                      | 1.41738       |                  |                  |                  |                  |
| Zinc chloride.....  | 1.209           | 26.4             | 1.37292                                  | 1.37515          | 1.38026          | .....                      | 1.38845       |                  |                  |                  |                  |
| Solutions in Ethyl Alcohol  |                 |                  |  |                  |                  |                            |               |                  |                  |                  |                  |
| Ethyl alcohol.....  | .....           | 25.5             | 1.35971                                  | 1.35971          | 1.36395          | .....                      | 1.37094       |                  |                  |                  |                  |
| Ethyl alcohol.....  | .....           | 27.6             | 1.35372                                  | 1.35556          | 1.35986          | .....                      | 1.36662       |                  |                  |                  |                  |
| Fuchsin (nearly saturated).....   | .....           | 16.0             | 1.3918                                   | 1.398            | 1.361            | .....                      | 1.3759        |                  |                  |                  |                  |
| Cyanin (saturated).....   | .....           | 16.0             | 1.3831                                   | .....            | 1.3705           | .....                      | 1.3821        |                  |                  |                  |                  |
| Note: Cyanin in chloroform also acts anomalously; for example, Sieben gives for a 4.5% solution $\mu_A = 1.4593$ , $\mu_B = 1.4695$ , $\mu_F$ (green) = 1.4514, $\mu_G$ (blue) = 1.4554. For a 9.9% solution he gives $\mu_A = 1.4902$ , $\mu_F$ (green) = 1.4497, $\mu_G$ (blue) = 1.4597. |                 |                  |  |                  |                  |                            |               |                  |                  |                  |                  |
| Solutions of Potassium Permanganate in Water  |                 |                  |  |                  |                  |                            |               |                  |                  |                  |                  |
| Wave-length, $\mu\text{m}$  | Spectrum line   | Index for 1% sol | Index for 2% sol                         | Index for 3% sol | Index for 4% sol | Wave-length, $\mu\text{m}$ | Spectrum line | Index for 1% sol | Index for 2% sol | Index for 3% sol | Index for 4% sol |
| 0.687   | B               | 1.3328           | 1.3342                                   | .....            | 1.3382           | 0.510                      | ...           | 1.3368           | 1.3385           | .....            | .....            |
| 0.656   | C               | 1.3335           | 1.3348                                   | 1.3365           | 1.3391           | 0.500                      | ...           | 1.3374           | 1.3383           | 1.3386           | 1.3404           |
| 0.617   | ...             | 1.3343           | 1.3365                                   | 1.3381           | 1.3410           | 0.486                      | F             | 1.3377           | .....            | .....            | 1.3408           |
| 0.594   | ...             | 1.3354           | 1.3373                                   | 1.3393           | 1.3426           | 0.480                      | ...           | 1.3381           | 1.3395           | 1.3398           | 1.3413           |
| 0.589   | D               | 1.3353           | 1.3372                                   | .....            | 1.3426           | 0.464                      | ...           | 1.3397           | 1.3402           | 1.3414           | 1.3423           |
| 0.568   | ...             | 1.3362           | 1.3387                                   | 1.3412           | 1.3445           | 0.447                      | ...           | 1.3407           | 1.3421           | 1.3426           | 1.3439           |
| 0.553   | ...             | 1.3366           | 1.3395                                   | 1.3417           | 1.3438           | 0.434                      | ...           | 1.3417           | .....            | .....            | 1.3452           |
| 0.527   | E               | 1.3363           | .....                                    | .....            | .....            | 0.423                      | ...           | 1.3431           | 1.3442           | 1.3457           | 1.3468           |
| 0.522   | ...             | 1.3362           | 1.3377                                   | 1.3388           | .....            | .....                      | .....         | .....            | .....            | .....            | .....            |

\* "Smithsonian Physical Tables," 1954, Table 552.

TABLE 6e-3. LIQUIDS USED FOR DETERMINING REFRACTIVE INDEX BY TRANSMISSION METHOD\*

| Liquid   | $N_D, 24^\circ\text{C}$ |
|--|-------------------------|
| Trimethylene chloride.....   | 1.446                   |
| Cineole.....   | 1.456                   |
| Hexahydrophenol.....   | 1.466                   |
| Decahydronaphthalene.....  | 1.477                   |
| Isoamylphthalate.....  | 1.486                   |
| Tetrachloroethane.....   | 1.492                   |
| Pentachloroethane.....   | 1.501                   |
| Trimethylene bromide.....  | 1.513                   |
| Chlorobenzene.....   | 1.523                   |
| Ethylene bromide + chlorobenzene.....                                      | 1.533                   |
| <i>o</i> -Nitrotoluene.....  | 1.544                   |
| Xylidine.....  | 1.557                   |
| <i>o</i> -Toluidine.....   | 1.570                   |
| Aniline.....   | 1.584                   |
| Bromoform.....   | 1.595                   |
| Iodobenzene + bromobenzene.....  | 1.603                   |
| Iodobenzene + bromobenzene.....  | 1.613                   |
| Quinoline.....   | 1.622                   |
| $\alpha$ -Chloronaphthalene.....   | 1.633                   |
| $\alpha$ -Bromonaphthalene + $\alpha$ -chloronaphthalene.....              | 1.640-1.650             |
| $\alpha$ -Bromonaphthalene + $\alpha$ -iodonaphthalene.....                | 1.660-1.690             |
| Methylene iodide + iodobenzene.....  | 1.700-1.730             |
| Methylene iodide.....  | 1.738                   |
| Methylene iodide saturated with sulfur.....                                | 1.78                    |
| Yellow phosphorus, sulfur, and methylene iodide† (8:1:1<br>by weight)..... | 2.06                    |

\* "Handbook of Chemistry and Physics," 36th ed., p. 2669, Chemical Rubber Publishing Company, 1954-1955.

† Can be diluted with methylene iodide to cover range 1.74-2.06. For precautions in use, cf. West, *Am. Mineralogist* 21, 245-249 (1936).

TABLE 6e-4. INDEX OF REFRACTION OF PLASTICS\*  
Optical Plastics

| Name of monomer   | Optical properties of polymer   |                             | Name of monomer  | Optical properties of polymer   |                             |
|---|---------------------------------|-----------------------------|--|---------------------------------|-----------------------------|
|   | Refractive index ( $N_D^{20}$ ) | Reciprocal dispersive power |  | Refractive index ( $N_D^{20}$ ) | Reciprocal dispersive power |
| <i>p</i> -Methoxy styrene   | 1.5967                          | 28                          | Allyl methacrylate                                     | 1.5196                          | 49.0                        |
| $\beta$ -Amino-ethyl methacrylate   | 1.537                           | 52.5                        | Benzhydryl methacrylate                                | 1.5933                          | 31.0                        |
| Methyl $\alpha$ -bromoacrylate  | 1.5672                          | 46.5                        | Benzyl methacrylate                                    | 1.5680                          | 36.5                        |
| Vinyl benzoate  | 1.5775                          | 30.7                        | <i>n</i> -Butyl methacrylate                           | 1.483                           | 49                          |
| Phenyl vinyl ketone   | 1.588                           | 26.0                        | <i>Tert</i> -butyl methacrylate                        | 1.4638                          | 51                          |
| Vinyl carbazole   | 1.683                           | 18.8                        | $\alpha$ -Chlorobenzhydryl methacrylate                | 1.6040                          | 30                          |
| Lead methacrylate   | 1.645                           | 28                          | $\alpha$ -( <i>o</i> -Chlorophenyl)-ethyl methacrylate | 1.5624                          | 37.5                        |
| 2-Chlorocyclohexyl methacrylate   | 1.5179                          | 56                          | Cyclohexyl-cyclohexyl methacrylate                     | 1.5250                          | 53                          |
| 1-Phenyl-cyclohexyl methacrylate  | 1.5645                          | 40                          | Cyclohexyl methacrylate                                | 1.6064                          | 50.9                        |
| Triethoxy-silicol methacrylate  | 1.436                           | 53                          | <i>p</i> -Cyclohexyl-phenyl methacrylate               | 1.5575                          | 39.0                        |
| <i>p</i> -Bromophenyl methacrylate  | 1.5964                          | 33                          | $\alpha$ - $\beta$ -Diphenyl-ethyl methacrylate        | 1.5816                          | 30.5                        |
| 2-3 Dibromopropyl methacrylate  | 1.5739                          | 44                          | Menthyl methacrylate                                   | 1.4890                          | 54.5                        |
| Diethyl-amino-ethyl methacrylate  | 1.5174                          | 54                          | Ethylene dimethacrylate                                | 1.5063                          | 53.4                        |
| 1-Methyl-cyclohexyl methacrylate  | 1.5111                          | 54                          | Hexamethylene glycol dimethacrylate                    | 1.5066                          | 56                          |
| <i>n</i> -Hexyl methacrylate  | 1.4813                          | 57                          | Methacrylic anhydride                                  | 1.5228                          | 48.5                        |
| 2-6-Dichlorostyrene   | 1.6248                          | 31.3                        | Methyl methacrylate                                    | 1.4913                          | 57.8                        |
| $\beta$ -Bromo-ethyl methacrylate   | 1.5426                          | 40                          | <i>m</i> -Nitro-benzyl methacrylate                    | 1.5845                          | 27.4                        |
| $\mu$ -Polychloroprene  | 1.5540                          | 36                          | 2-Nitro-2-methyl-propyl methacrylate                   | 1.4868                          | 48                          |
| Methyl $\alpha$ -chloroacrylate   | 1.5172                          | 57                          | $\alpha$ -Phenyl-allyl methacrylate                    | 1.5573                          | 34.8                        |
| $\beta$ -Naphthyl methacrylate  | 1.6298                          | 24                          | $\alpha$ -Phenyl- <i>n</i> -amyl methacrylate          | 1.5396                          | 40                          |
| Vinyl phenyl sulfide  | 1.6568                          | 27.5                        | $\alpha$ -Phenyl-ethyl methacrylate                    | 1.5487                          | 37.5                        |
| Methacryl methyl salicylate   | 1.5707                          | 34                          | $\beta$ -Phenyl-ethyl methacrylate                     | 1.5592                          | 36.5                        |
| Methyl isopropenyl ketone   | 1.5200                          | 54.5                        | Tetrahydrofurfuryl methacrylate                        | 1.5096                          | 54                          |
| Ethylene glycol mono-methacrylate   | 1.5119                          | 56                          | Vinyl methacrylate                                     | 1.5129                          | 46                          |
| <i>N</i> -Benzyl methacrylamide   | 1.5965                          | 34.5                        | Styrene  | 1.5907                          | 30.8                        |
| $\beta$ -Phenyl-sulfone ethyl methacrylate  | 1.5682                          | 39                          | Vinyl formate  | 1.4757                          | 55                          |
| <i>N</i> -Methyl methacrylamide   | 1.5398                          | 47.5                        | Phenyl cellosolve methacrylate                         | 1.5624                          | 30.2                        |
| <i>N</i> -Allyl methacrylamide  | 1.5476                          | 47                          | <i>p</i> -Methoxy-benzyl methacrylate                  | 1.552                           | 32.5                        |
| Methacryl-phenyl salicylate   | 1.6006                          | 36                          | Ethylene chlorohydrin methacrylate                     | 1.517                           | 54                          |
| <i>N</i> - $\beta$ -Methoxyethyl methacrylamide                                   | 1.5246                          | 53                          | <i>o</i> -Chlorostyrene                                | 1.6098                          | 31                          |
| <i>N</i> - $\beta$ -Phenylethyl methacrylamide                                    | 1.5857                          | 37                          | Pentachlorophenyl methacrylate                         | 1.608                           | 22.5                        |
| Cyclohexyl $\alpha$ -ethoxyacrylate   | 1.4969                          | 58                          | Phenyl methacrylate                                    | 1.5706                          | 35.0                        |
| 1-3-Dichloropropyl-2-methacrylate   | 1.5270                          | 56                          | Vinyl naphthalene                                      | 1.6818                          | 20.9                        |
| 2-Methyl-cyclohexyl methacrylate  | 1.5028                          | 53                          | Vinyl thiophene  | 1.6376                          | 29                          |
| 3-Methyl-cyclohexyl methacrylate  | 1.4947                          | 55                          | Eugenol methacrylate                                   | 1.5714                          | 33                          |
| 3-3-5-Trimethyl-cyclohexyl methacrylate   | 1.485                           | 54                          | <i>m</i> -Cresyl methacrylate                          | 1.5683                          | 36.8                        |
| <i>N</i> -Vinyl phthalimide   | 1.6200                          | 24.1                        | <i>o</i> -Methyl- <i>p</i> -methoxy styrene            | 1.5868                          | 30.3                        |
| Fluorenyl methacrylate  | 1.6319                          | 23.1                        | <i>o</i> -Methoxy styrene                              | 1.5932                          | 29.7                        |
| $\alpha$ -Naphthyl-carbinyl methacrylate  | 1.63                            | 25                          | <i>o</i> -Methyl styrene                               | 1.5674                          | 32                          |
| <i>p</i> - <i>p</i> '-Xylylenyl dimethacrylate                                    | 1.5559                          | 37                          | Ethyl sulfide dimethacrylate                           | 1.547                           | 44                          |
| Cyclohexanediol-1-4 dimethacrylate  | 1.5067                          | 54.3                        | Allyl cinnamate  | 1.57                            | 30                          |
| Ethylidene dimethacrylate   | 1.4831                          | 52.9                        | Diacetin methacrylate                                  | 1.4855                          | 50                          |
| <i>p</i> -Divinyl benzene   | 1.6150                          | 28.1                        | Ethylene glycol benzoate methacrylate                  | 1.555                           | 36.8                        |
| Decamethylene glycol dimethacrylate   | 1.4990                          | 56.3                        | Ethyl glycolate methacrylate                           | 1.4903                          | 55                          |
| Vinyl cyclohexene dioxide   | 1.5303                          | 56.4                        | <i>p</i> -Isopropyl styrene                            | 1.554                           | 35                          |
| Methyl $\alpha$ -methylene butyrolactone  | 1.5118                          | 53.9                        | Bornyl methacrylate                                    | 1.5059                          | 54.6                        |
| $\alpha$ -Methylene butyrolactone   | 1.5412                          | 56.4                        | Triethyl carbinyl methacrylate                         | 1.4889                          | 57                          |
| 4-Dioxolymethyl methacrylate  | 1.5094                          | 59.7                        | Butyl mercaptanyl methacrylate                         | 1.5390                          | 41.8                        |
| Methylene- $\alpha$ -valerolactone  | 1.5431                          | 47.8                        | <i>o</i> -Chlorobenzyl methacrylate                    | 1.5823                          | 37                          |
| <i>o</i> -Methoxy-phenyl methacrylate   | 1.5705                          | 33.4                        | $\alpha$ -Methallyl methacrylate                       | 1.4917                          | 49                          |
| Isopropyl methacrylate  | 1.4728                          | 57.9                        | $\beta$ -Methallyl methacrylate                        | 1.5110                          | 47                          |
| Trifluoroisopropyl methacrylate   | 1.4177                          | 65.3                        | $\alpha$ -Naphthyl methacrylate                        | 1.6411                          | 20.5                        |
| $\beta$ -Ethoxy-ethyl methacrylate  | 1.4833                          | 32.0                        | Ethyl acrylate   | 1.4685                          | 58                          |
| Name of polymer   |                                 |                             | Cinnamyl methacrylate                                  | 1.5951                          | 26.5                        |
| Condensation resin from di- ( <i>p</i> -aminocyclohexyl) methane and sebacic acid | 1.5199                          | 52.0                        | Methyl acrylate  | 1.4793                          | 59                          |
| Columbia resin 39   | 1.5001                          | 58.8                        | Terpineyl methacrylate                                 | 1.514                           | 50                          |
|   |                                 |                             | Furfuryl methacrylate                                  | 1.5381                          | 39.2                        |

\* H. C. Raine, Plastic Glasses, Proc. London Conf. Opt. Instruments 1950, 243.

TABLE 6e-4. INDEX OF REFRACTION OF PLASTICS\* (Continued)

| Polystyrene    |               |                     |                    |                    |
|----------------|---------------|---------------------|--------------------|--------------------|
| Spectral line  | Wavelength, Å | Refractive index at |                    |                    |
|                |               | 15°C                | 35°C               | 55°C               |
| A              | 7,679         | 1.581 <sup>2</sup>  | 1.578 <sup>5</sup> | 1.575 <sup>8</sup> |
| C              | 6,563         | 1.587 <sup>0</sup>  | 1.584 <sup>3</sup> | 1.581 <sup>6</sup> |
| D <sub>1</sub> | 5,896         | 1.592 <sup>3</sup>  | 1.589 <sup>7</sup> | 1.586 <sup>9</sup> |
| F              | 4,861         | 1.606 <sup>2</sup>  | 1.603 <sup>4</sup> | 1.600 <sup>6</sup> |
| g              | 4,358         | 1.617 <sup>6</sup>  | 1.614 <sup>8</sup> | 1.612 <sup>0</sup> |

  

| Polycyclohexyl Methacrylate |               |                     |                    |                    |
|-----------------------------|---------------|---------------------|--------------------|--------------------|
| Spectral line               | Wavelength, Å | Refractive index at |                    |                    |
|                             |               | 15°C                | 35°C               | 55°C               |
| A                           | 7,679         | 1.501 <sup>6</sup>  | 1.499 <sup>2</sup> | 1.496 <sup>4</sup> |
| C                           | 6,563         | 1.504 <sup>4</sup>  | 1.502 <sup>1</sup> | 1.499 <sup>2</sup> |
| D <sub>1</sub>              | 5,896         | 1.507 <sup>1</sup>  | 1.504 <sup>6</sup> | 1.501 <sup>8</sup> |
| F                           | 4,861         | 1.513 <sup>4</sup>  | 1.501 <sup>0</sup> | 1.508 <sup>1</sup> |
| g                           | 4,358         | 1.518 <sup>4</sup>  | 1.516 <sup>0</sup> | 1.513 <sup>1</sup> |

  

| Polymethyl Methacrylate |               |                          |
|-------------------------|---------------|--------------------------|
| Spectral line           | Wavelength, Å | Refractive index at 20°C |
| C                       | 6,563         | 1.489 <sup>0</sup>       |
| D                       | 5,896         | 1.491 <sup>3</sup>       |
| e                       | 5,461         | 1.493 <sup>2</sup>       |
| F                       | 4,861         | 1.497 <sup>5</sup>       |
| g                       | 4,358         | 1.501 <sup>8</sup>       |

TABLE 6e-5. INDEX OF REFRACTION OF GASES AND VAPORS\*

| Wave-length,<br>$\mu\text{m}$ | $(n - 1)10^3 \dagger$ |                |                |                | Wave-length,<br>$\mu\text{m}$ | $(n - 1)10^3 \dagger$ |                |                 |                |
|-------------------------------|-----------------------|----------------|----------------|----------------|-------------------------------|-----------------------|----------------|-----------------|----------------|
|                               | Air                   | O <sub>2</sub> | N <sub>2</sub> | H <sub>2</sub> |                               | Air                   | O <sub>2</sub> | CO <sub>2</sub> | H <sub>2</sub> |
| 0.4861                        | 0.2951                | 0.2734         | 0.3012         | 0.1406         | 0.4360                        | 0.2971                | 0.2743         | 0.4563          | 0.1418         |
| 0.5461                        | 0.2936                | 0.2717         | 0.2998         | 0.1397         | 0.5461                        | 0.2937                | 0.2704         | 0.4506          | 0.1397         |
| 0.5790                        | 0.2930                | 0.2710         | .....          | 0.1393         | 0.6709                        | 0.2918                | 0.2683         | 0.4471          | 0.1385         |
| 0.6563                        | 0.2919                | 0.2698         | 0.2982         | 0.1387         | 6.709                         | 0.3881                | 0.2643         | 0.4804          | 0.1361         |
|                               |                       |                |                |                | 8.678                         | 0.2888                | 0.2650         | 0.4579          | 0.1361         |

\* The values are for 0°C and 760 mm Hg.

† Cuthbertson, 1910.

‡ Koch, 1000.

| Substance             | Kind of light | Indices of refraction | Substance            | Kind of light | Indices of refraction |
|-----------------------|---------------|-----------------------|----------------------|---------------|-----------------------|
| Acetone.....          | D             | 1.001079-1.001100     | Hydrogen.....        | White         | 1.000138-1.000143     |
| Ammonia.....          | White         | 1.000381-1.000385     | Hydrogen.....        | D             | 1.000132              |
| Ammonia.....          | D             | 1.000373-1.000379     | Hydrogen sulfide.... | D             | 1.000644              |
| Argon.....            | D             | 1.000281              |                      | D             | 1.000623              |
| Benzene.....          | D             | 1.001700-1.001823     | Methane.....         | White         | 1.000443              |
| Bromine.....          | D             | 1.001132              | Methane.....         | D             | 1.000444              |
| Carbon dioxide.....   | White         | 1.000449-1.000450     | Methyl alcohol.....  | D             | 1.000549-1.000623     |
| Carbon dioxide.....   | D             | 1.000448-1.000454     | Methyl ether.....    | D             | 1.000891              |
| Carbon disulfide..... | White         | 1.001500              | Nitric oxide.....    | White         | 1.000303              |
|                       | D             | 1.001478-1.001485     | Nitric oxide.....    | D             | 1.000297              |
| Carbon monoxide....   | White         | 1.000340              | Nitrogen.....        | White         | 1.000295-1.000300     |
|                       | White         | 1.000335              | Nitrogen.....        | D             | 1.000296-1.000298     |
| Chlorine.....         | White         | 1.000772              | Nitrous oxide.....   | White         | 1.000503-1.000507     |
| Chlorine.....         | D             | 1.000773              | Nitrous oxide.....   | D             | 1.000516              |
| Chloroform.....       | D             | 1.001436-1.001464     | Oxygen.....          | White         | 1.000272-1.000280     |
| Cyanogen.....         | White         | 1.000834              | Oxygen.....          | D             | 1.000271-1.000272     |
| Cyanogen.....         | D             | 1.000794-1.000825     | Pentane.....         | D             | 1.001711              |
| Ethyl alcohol.....    | D             | 1.000871-1.000885     | Sulfur dioxide.....  | White         | 1.000665              |
| Ethyl ether.....      | D             | 1.001521-1.001544     | Sulfur dioxide.....  | D             | 1.000686              |
| Helium.....           | D             | 1.000036              | Water.....           | White         | 1.000261              |
| Hydrochloric acid.... | White         | 1.000449              | Water.....           | D             | 1.000249-1.000259     |
|                       | D             | 1.000447              |                      |               |                       |

\* "Smithsonian Physical Tables," 1954, Table 554. A formula was given by Biot and Arago expressing the dependence of the index of refraction of a gas on pressure and temperature. More recent experiments confirm their conclusions. The formula is  $n_t - 1 = \frac{n_0 - 1}{1 + \alpha t} \frac{p}{760}$ , where  $n_t$  is the index of refraction for temperature  $t$ ,  $n_0$  for temperature zero,  $\alpha$  the coefficient of expansion of the gas with temperature, and  $p$  the pressure of the gas in millimeters of mercury.

## AIR

D. H. Rank, in an article in "Advances in Spectroscopy," vol. I, indicates that the Edlen formula for the dispersion of air agrees with experimental data from the ultra-violet (2,000 Å) to the near infrared (2.06 μm).

The equations are for air free of carbon dioxide at standard conditions and for standard air (dry, 0.03 percent carbon dioxide), respectively:

$$(n - 1)10^8 = 6,431.8 + \frac{2,949,330}{146 - \sigma^2} + \frac{25,536}{41 - \sigma^2}$$

$$(n - 1)10^8 = 6,432.8 + \frac{2,949,810}{146 - \sigma^2} + \frac{25,540}{41 - \sigma^2}$$

$\sigma$  is the wave number in  $\mu\text{m}^{-1}$ .

Furthermore, Rank reports the equation of Barrell and Sears for the change of index with temperature and pressure:

$$n_{T,p} - 1 = (n_{15,760} - 1) \frac{p(1 + p\beta_T)(1 + 15\alpha)}{760(1 + 760\beta_{15})(1 + \alpha T)}$$

where  $T$  = temperature

$p$  = pressure

$\alpha$  = 0.00366

$\beta_T = (1.049 - 0.0157T)10^{-6}$

$\beta_{15} = 0.8135 \times 10^{-6}$